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PATENT SPECIFICATION

Convention Date (United States): May 12, 1938. **528,588**

Application Date (In United Kingdom): May 9, 1939. No. 13886/39.

Complete Specification Accepted: Nov. 1, 1940.

COMPLETE SPECIFICATION

Apparatus for Colour Photography

I, LUIGI CRISTIANI, an Italian subject, of Via Torina 3, Voghera, Italy, formerly of 695, Myrtel Avenue, Brooklyn, New York, United States of America, and previously of 180, Washington Park, Brooklyn, New York, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

My invention relates to apparatus for colour photography and more particularly to apparatus for photographing colour record images on a film or other base in such a manner that a picture may be projected therefrom in colours simulating or approaching the natural colouring of the subject, it being understood that my invention applies to motion pictures as well as "stills".

It will be obvious that in order to produce a clear projected picture of colour value approaching that of the subject photographed, the several colour record images on the film must be exactly, or almost exactly, superimposed on the projection screen. For practical results, a tolerance of not more than one hundredth of a millimeter is permissible in the separation of the colour record images on the film.

In Specification No. 509,269 there is shown an apparatus for colour photography and cinematography, by which a plurality of colour record images may be formed or projected.

In the optical system according to that Specification, the distance between the window screen and the prism is fixed for a given size of window and a fixed prism angle. Exact superposition of the projected image may be obtained with the prior apparatus only for objects which, during photographing, focus in the focal plane of the first objective, that is, those objects which are in focus in the window aperture. Since the prism must be a fixed distance from the focal plane of the first objective, that is, from the window screen, those objects focusing in front of or behind the window screen will exhibit a slight parallax in the images juxtaposed on the film, thus introducing a slight fuzziness in the projected picture.

According to the present invention, an objective lens is arranged at its focal distance from the window screen so that rays of light passing through this additional objective lens will be in substantially parallel beams. The prism angle will depend upon the size of the window and the focal length of the lens producing the parallel beams. A reduction in the size of the window will call for reduction of the prism angle and an increase in the size of the window will call for an increase in the prism angle with the same focal length lens. By movement of the prism away from the window, with the new arrangement, it will be possible to reduce parallax error to a minimum as there is no appreciable loss of light due to the fact that the light beams are projected from the additional objective lens in substantially parallel beams. The additional lens, hereinafter referred to as the second objective, may project the light beams with a slight convergence or a slight divergence. The position of the second objective with respect to the window aperture will determine whether the light beams are parallel, convergent or divergent. If the second objective is positioned at a distance equal to its focal length from the window aperture, the light beams will be parallel. Light beams from objects short of focus will be slightly divergent and light beams of objects beyond the focal distance will be slightly convergent.

When the light beams are convergent or divergent, any movement of the prism produces a difference in the displacements between the final images of the window. With convergent light, when the prism is moved towards the window from a point at which it causes the final images to be in juxtaposition, there are produced displacements of the projected images, in directions separating them. If, on the other hand, the prism is moved away from the window, the images come together and superpose.

The image, when focused at the window, will be projected in parallel

rays by the second objective. Objects focusing in front of the window screen will produce convergent light beams when projected through the second objective resulting in images on the film which are out of focus and will not properly superpose on the screen during projection due to parallax. This parallax however, can be substantially eliminated, during photographing, by movement of the prism away from the window without affecting the superimposing of the objects which are in focus.

The accompanying drawing is a diagrammatic view showing an optical system according to the present invention, it being understood, of course, that the same system is to be used for projecting with a light source behind the transparent film.

Referring now to the drawing, an opaque screen 1 is formed with a window aperture 2 which may be of any suitable size. Assuming for purposes of illustration but not by way of limitation, that there is employed a standard 35 millimeter film, a square window aperture of dimensions 36 × 36 millimeters may be used.

An objective lens 3 which may be of any suitable type is adapted to focus an image of an object 4 upon the screen 1 so that, if a ground glass were placed in the window aperture 2, the image of the object 4 would be reproduced on the ground glass in exact focus. The second objective 18 of any suitable type is positioned at a distance equal to its focal length behind the screen 1. As pointed out hereinabove, the light from the image of the object (5) in focus in the window aperture 2 will be projected by the second objective 18 in parallel beams. Objects out of focus having a focal point in front of the window will produce convergent beams of light when projected by the second objective 18.

A prism 5, preferably out of one piece of glass, is provided with four faces, the angles of which are the same as the angles produced by drawing diagonals across the window which is used. For example, where the window is square the angle 6 may be 90° plus or minus 10 seconds, since a deviation of 15 seconds will be sufficiently accurate for practical purposes. For objects focusing exactly in the aperture 2 of the window screen 1, the prism 5 may be moved toward or away from the window screen 1 without affecting the juxtaposition of the plurality of images formed by the prism and a third objective 7. The parallax produced in the final image by objects out of focus can be substantially eliminated by moving the prism away from the window, thus enabling the third objective 7 to project four geometrically similar images in exact juxtaposition upon a sensitised surface 13. It will be understood, of course, that the dimensions of the images projected by lens 7 will vary in accordance with the focal length of this lens. It will be obvious that, with a 35 millimeter film, if it is desired, for example, to form four images each of which is 9 × 9 millimeters, in order that the total height may remain within the moving picture height of 18 millimeters, the lens 7 must have such a focal length as to reduce the size of the window aperture from 36 × 36 millimeters to 9 × 9 millimeters.

The prism 5 is always placed in such a position as to give four images in exactly juxtaposed position, that is, the bottom of the upper left-hand image will form the border line of the upper border of the lower left-hand image and the right-hand border line of the upper left-hand image will exactly coincide with the left border line of the upper right-hand image. Similarly, the lower border line of the upper right-hand image will exactly coincide with the upper border line of the lower right-hand image and the left border line of the lower right-hand image will coincide with the right border line of the lower left-hand image. In this manner, inaccuracies or dissimilarities in several lenses will have no effect upon the accuracy of superimposition when the film is projected, as will be hereinafter more fully described. It will be obvious to those skilled in th art that the sole determining feature of accuracy of superimposition will depend upon the accuracy with which the prism 5 is made.

For colour photography each of the images will be such that it will be made substantially by the action of a single colour, which result is obtained by the use of filters. The filter may be interposed between the multiple prism and the sensitive surface, whereby one of the images, for example, will be made substantially by red light, filter 14 allowing red rays to pass. Filter 15 allows an image made by blue light, the filter being such as to allow blue rays to pass. Filter 16 allowing green rays to pass, the image produced on the film will be made preponderantly by green light, and an image passing through yellow filter 17 will affect the film largely by yellow light. It is understood, of course, that the film must be panchromatic, that is, it must be sensitive to all colours. It is also understood, of course, that the filter must be accurately aligned. The filter

may be placed in any desired position, and if desired, the four inclined faces of the prism 5 may be tinted to act as filters, thus insuring at all times that each image will be of desired monochrome.

The manner of projection of the film to obtain a coloured image will be clear to those skilled in the art. From the negative obtained, a positive is printed on film if it is desired to have coloured moving pictures. Each of the images having been formed by monochrome light, will represent a similar proportion of that particular colour in the subject which was photographed. The film is accommodated in place of the sensitive surface and each of the images is passed through a filter of colour corresponding to that with which it was taken and the prism will combine the various images into one, superimposing them exactly upon the focal plane of the objective lens 3, forming a complete picture in natural colours analogous to that obtained by four colour printing.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

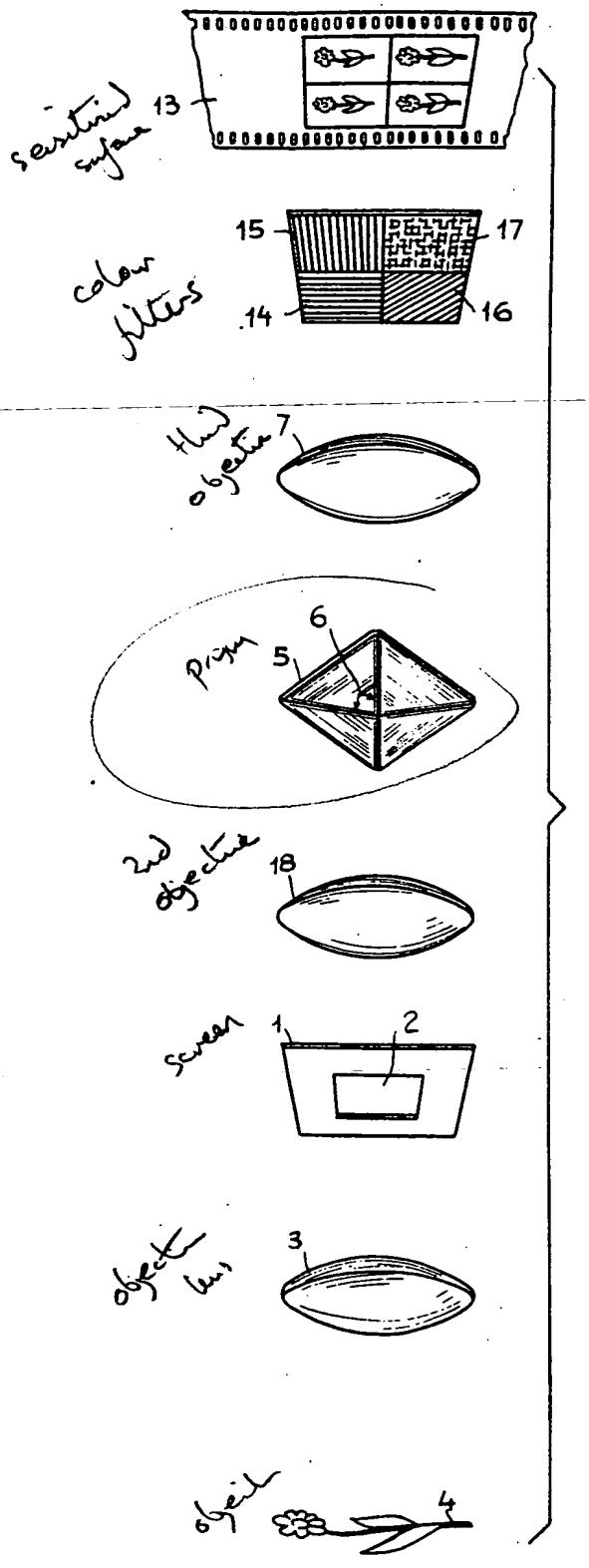
1. Optical device for photography and cinematography in colour comprising a multiple prism adapted to receive light from an image formed by an objective lens in an interposed window, and to divide the light in such a manner that a plurality of like, separate images can be formed by another objective lens, arranged behind the multiple prism, upon a photo-sensitive surface disposed in a suitable position, characterised by the provision of an additional objective lens interposed between the window and the multiple prism and adapted to project the light from the image formed in the window in a substantially parallel beam upon the multiple prism.

2. Optical device according to claim 1, wherein there is interposed between the multiple prism and the sensitive surface a filter having a number of coloured elements corresponding to the number of images produced by the multiple prism, each of the elements of this filter being exactly aligned with the axis of emergence of the corresponding image.

3. Optical device for use in the projection of pictures in colour, according to claim 1 or 2, wherein a transparency to be reproduced can be accommodated in place of the photo-sensitive surface, the said optical device being adapted to combine light from a plurality of images on said transparency to form a single coloured image on a suitably disposed screen.

4. Optical device for producing multiple colour equivalent images by photography or cinematography or for projecting such images, substantially as described.

Dated this 9th day of May, 1939.
REDDIE & GROSE,
Agents for the Applicant,
6, Bream's Buildings, London, E.C.4.



Malby & Sons, Photo-Lith.